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## **Commercialization of Sorghum Milling in Botswana: Trends and Prospects**

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**International Crops Research Institute for the Semi-Arid Tropics**

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### **Abstract**

Commercial sorghum processing in Botswana has grown rapidly during the past decade. The number of sorghum millers has increased four-fold, and sorghum meal has become competitive with maize in urban and rural food markets.

In early 1999, ICRISAT conducted a study of the factors underlying this growth, and the prospects for further market expansion. The study showed that growth was driven largely by four factors: the traditional consumer preference for sorghum meal; strong financial support to millers from the government; the availability of reliable, high-quality supplies of grain; and effective promotion of processing technology by a parastatal agency. However, development of the milling industry had little impact on domestic sorghum production. Productivity in Botswana remains too low for the crop to compete with South African imports, and only 2% of the industry's grain purchases are grown domestically.

Key issues likely to affect future expansion include the identification of alternative sources of grain supplies (e.g. Zimbabwe); improvements in product promotion, market intelligence, and product differentiation (e.g. targeting distinct products for breakfast porridge vs stiff porridge); and the prospects for industry consolidation into a few larger millers. While the Botswana case is not specifically replicable in neighboring countries, the stimulus created by linking technology, finance, and raw material supply offers important lessons for the development of commercial crop processing throughout southern Africa.

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## Acronyms

AFA	Automatic Financial Assistance
ARAP	Accelerated Rainfed Arable Programme
BAMB	Botswana Agricultural Marketing Board
FAP	Financial Assistance Policy
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre
IICT	Instituto de Investigacao Cientifica Tropical
RIIC	Rural Industries Innovation Centre

## Summary

Commercial sorghum processing in Botswana has grown rapidly during the past decade. In 1989, the country had 36 small-scale sorghum mills, most operating on a service basis, milling grain by the bucket or bag on behalf of individual consumers. By 1999, the number of small- and medium-scale sorghum mills had increased four-fold. The majority of these mills now buy grain for processing and sale through local retail shops and supermarkets. The status of sorghum has changed from being a food security crop largely consumed in the rural areas, to become a commercial crop competing in the urban food market.

This report reviews the factors underlying the growth of the sorghum milling industry in Botswana, and the prospects for further market expansion. The development and expansion of the industry was due largely to the ready availability of suitable processing technology, provision of capital grants for commercial investment, and consistent access to high quality grain. Grain supplies have been facilitated by the reduction of barriers to sorghum grain imports. In addition, growth of the retail market is driven by strong consumer demand for sorghum meal.

The analysis highlights the fact that commercialization of sorghum processing had only limited impact on domestic sorghum production. Though sorghum is Botswana's main crop, most of the grain flowing through the domestic milling industry is imported from neighboring countries, principally South Africa. This is mainly because sorghum productivity in Botswana remains low. Yields average less than 250 kg ha<sup>-1</sup>. In the smallholder sector, returns to labor invested in sorghum production are generally lower than the rural wage rate. This has encouraged migration out of agriculture. In the large-scale sector, farmers have shifted land into more profitable crops such as sunflower and cotton. It is unlikely, therefore, that domestic sorghum production will ever contribute more than a small share of industry requirements.

The report concludes by drawing lessons for the growth of related food processing industries in neighboring countries in southern Africa. Many aspects of the Botswana case are unique, including the relative strength of consumer demand for sorghum meal, and the magnitude of government financial support for development of the industry. However, the stimulus created by linking technology, finance, and raw material supply is broadly replicable across the region.

## Growth of Commercial Sorghum Milling

Sorghum is Botswana's traditional staple food. It accounts for approximately 80% of national crop area and three-quarters of cereal production. Yet, paradoxically, sorghum accounts for only about one-third of cereal grain consumption.

Low productivity and declining per-capita grain production have increased Botswana's reliance on cereal grain imports. During the late 1990s, the country imported approximately 80% of its grain supplies. Maize and wheat accounted for roughly three-quarters of these imports, but rice has been the fastest growing cereal grain import.

Income growth and urbanization encouraged greater consumption of wheat and rice in particular. Between 1986 and 1996, Botswana's Gross Domestic Product (GDP) rose at an average rate of 5.9% per year (World Bank 1998). National income growth, largely derived from diamond exports, has encouraged the movement of labor out of agriculture into the manufacturing and service sectors. The proportion of the labor force employed in agriculture declined from 70% in 1980 to only 42% in 1996 (African Development Bank 1998). By 1998, the majority of the country's population lived in urban areas.

The significance of rising rural labor costs was recognized as early as 1977 in a needs assessment survey carried out by the Rural Industries Innovation Centre (RIIC) (Mmapatsi and Maleke 1996). Women widely complained about the time required to pound sorghum by hand. In order to free women's labor for other more productive tasks, RIIC started developing and disseminating mechanical sorghum mills.

In 1979, RIIC established two prototype grain dehullers in two villages. By 1982, 17 sorghum mills, each including at least one dehuller and hammermill, had been established. RIIC supplied the machines, and offered a training course in machinery maintenance to entrepreneurs buying the machines, and to operators hired to run and maintain the equipment.

Most of these mills performed mainly service dehulling and milling for neighboring farmers. Small quantities of sorghum meal were sold from the mill or in nearby retail shops. By the late 1980s, only one medium-scale commercial sorghum mill had been established in the country.

Machine processing of sorghum was initially viewed primarily as a means to encourage the growth of sorghum production and consumption in rural areas. By reducing the drudgery of sorghum processing, households would be encouraged to expand production. However, in recent years, sorghum milling has grown mainly as a commercial enterprise.

Rapidly growing levels of wage employment have sharply increased the demand for processed food commodities. As the size of this market became recognized, the number of sorghum mills increased sharply (Table 1). Twenty new mills were established in 1990, and 33 mills were established between 1991 and 1995. Between 1996 and 1998, another 75 dehullers and hammermills were installed. New mills were being established virtually every month. Almost all these mills sought to produce sorghum meal for the retail market. The industry for the production of sorghum meal had become highly competitive.

**Table 1. Number of sorghum mills established in Botswana, 1979-99.**

	1979	1980-84	1985-89	1990-94	1995-99
Number of new mills	2	20	13	41	89

Source: RIIC 1999



**Table 2. Aggregate consumption of sorghum and maize, 1991-94 to 1995-98.**

	Sorghum (tons)	Maize (tons)
<b>1991-94 average</b>		
Production	25,650	8,475
Net imports	15,175	44,180
Estimated consumption	40,825	52,655
<b>1995-98 average</b>		
Production	28,796	8,780
Imports	44,115	56,090
Estimated consumption	72,911	64,870

Sources: FAO 1999 and Trade Statistics Unit, Republic of Botswana

By early 1999, RIIC had assisted with 166 installations of sorghum dehullers and hammermills for 146 entrepreneurs. The industry had shifted from providing service milling toward a concentration on commercial sorghum milling for the retail market. Growing interest was expressed in the milling of pearl millet. Several millers also started experimenting with maize processing.

The growth in the sorghum milling industry contributed to a sharp increase in the consumption of sorghum. In the early 1990s, almost 30% more maize was directly consumed as food than sorghum (Table 2). Virtually all of this was in the form of maize meal purchased in retail shops. During the latter part of the decade, sorghum overtook maize as the country's dominant cereal grain. This was largely the result of an increase in sorghum imports, destined mainly for the domestic milling industry.

According to recent consumer surveys, sorghum remains a preferred food grain for a large portion of Botswana's population (IICT 1997). In the urban market sorghum and maize appear to be relatively close substitutes. Large quantities of maize meal continue to be sold from supermarket shelves. However, the availability of sorghum meal has reduced the growth in sales of maize meal. Sorghum meal is now commonly sold by most retail grocery shops. Multiple brands of meal are available in larger shops.

Nonetheless, the prospects for future growth in sorghum consumption for food remain uncertain. Sorghum could replace a larger share of the maize being consumed in Botswana. But this is more likely to depend on improvements in the efficiency of sorghum milling, than on further growth in the number of mills.

## **Survey of Sorghum Millers**

The growth of commercial sorghum milling is evident in the number of mills established, and the widespread availability of sorghum meal on the Botswana market. However, little is known about the justification for the timing and speed of this growth. Why did it occur in the 1990s, rather than the 1980s, or earlier? Why did the growth take the form of a large number of small- and medium-scale milling operations rather than a few large companies? What factors are likely to determine the future of the industry?

In early 1999, a survey of sorghum millers was conducted to identify factors underlying the growth of the industry, and constraints to further expansion. The survey covered 24 sorghum millers or 16% of the estimated total number. The sample targeted a cross-section of millers distributed across Botswana's main population centers in the eastern half of the country (Fig. 1). The survey area encompasses 90% of Botswana's population, and all major urban centers except Maun.

The survey sample deliberately targeted larger millers with longer experience with sorghum milling. In addition, a cross-section of medium- and small-scale operators was sought. The sample is not random. However, the consistency of responses to the survey suggests the results can be generalized to the wider population of sorghum millers.

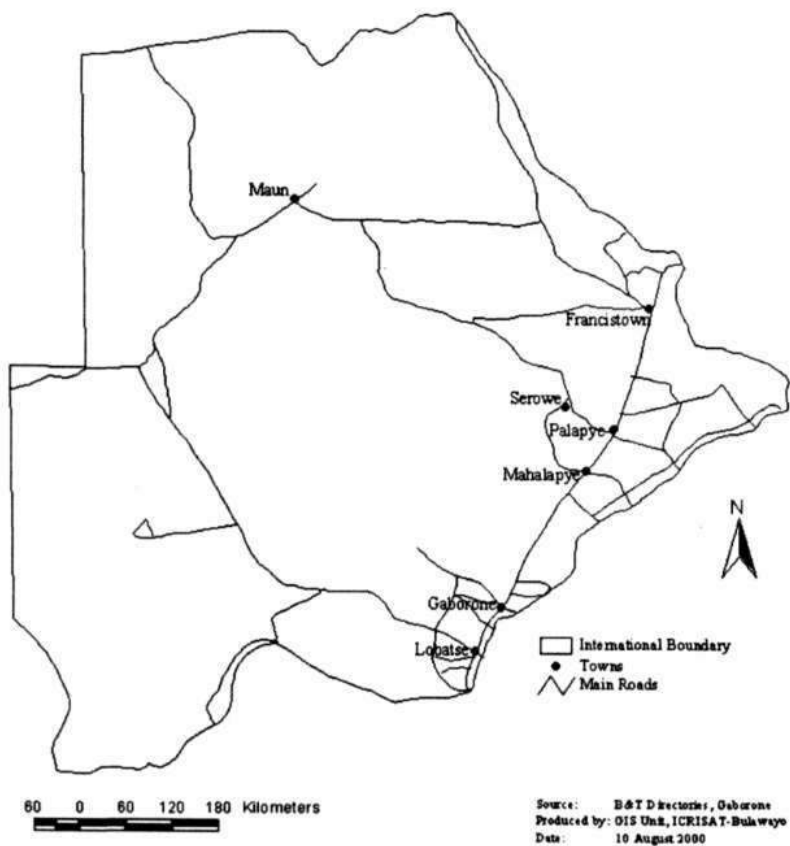


Figure 1. Major urban centers and roads in Botswana.

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**Table 3. Survey sample of sorghum millers, 1999.**

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Size of operation	Number of mills surveyed
Large commercial mills (milling 1500 t or more in 1998)	6 mills
Medium commercial mills (500-1500 t in 1998)	6 mills
Small commercial mills (< 500 t in 1998)	12 mills

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Six of the 24 millers in the sample established their operations before 1990; seven mills were established in 1997 or 1998.

Fifteen of the 24 millers own two or more dehullers. Most of these also own two or more hammermills. The remaining nine own only one dehuller and hammermill. Production for the market necessitates ownership of scales, and sewing or heat sealing machines to package sorghum meal. All the operators interviewed owned such equipment. Most also owned trucks to transport meal to the market.

In the analysis that follows, six millers who processed 1500 t of sorghum or more in 1998, were classified as large commercial mills (Table 3). These operations range in size from almost 2000 t to more than 15,000 t of annual throughput. These millers all aim to sell sorghum meal throughout the national market. Six mills with an average annual throughput of 500 to 1500 t are classified as medium sized. Their commercial sales tend to be localized, but most of these millers expect to expand production in the future. The remaining 12 mills are classified as small-scale.

All but two of the large mills reported that they continued to perform service milling. This practice is viewed as an obligation to the rural community, but is usually conducted on an extremely small scale because of low sorghum harvests during the past few years as a result of drought. Service throughput has also declined with the reduction in national sorghum area caused by the termination of government subsidies for sorghum production previously funded under the Accelerated Rainfed Arable Programme (ARAP). Only two of the small mills practice any significant amount of service milling.

In order to survive, all the mills now have to purchase sorghum grain for commercial milling. Correspondingly, all the mills surveyed claim to pursue commercial milling as their primary objective.

## **Sorghum Milling Technology**

The entire sorghum milling industry in Botswana is based on the use of a dehuller, for the decortication of grain, and a hammermill, for the production of meal. Small operators use single machines. Large mills employ a production line of several dehullers and hammermills.

The dehuller used by virtually all millers was introduced by RIIC in 1977. This machine was derived from a barley thresher originally manufactured in Canada.<sup>1</sup> It was modified on the basis of performance tests in Botswana, and then manufactured by RIIC for sale in Botswana. The hammermill is commonly used (and manufactured) throughout southern Africa for small-scale maize milling.

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1. The thresher was modified to include 13 evenly spaced carborundum stone wheels in a horizontal barrel lined with rubber. The machine allows the progressive abrasion of the outer layers of the grain as it passes through the dehuller barrel. Sorghum husks and bran are extracted by means of a suction system while the dehulled grain is collected via a side chute or bottom trap door. The dehuller can be run either continuously or in batch loads.

In the Botswana milling industry, sorghum grain is most commonly dehulled in batch mode and then manually fed into one or more hammermills. At least one large business runs a continuous dehulling and milling system, and others are considering this option.

Most dehullers in Botswana have a capacity of about 300 kg per hour, while hammermills have a capacity of 500 kg per hour (consequently most medium and large-scale businesses have more dehullers than hammermills). Larger mills use 2 or more dehullers in conjunction with 2 or more hammermills.

Sorghum grain can also be decorticated and milled through a roller mill. However, this option is substantially more expensive than the dehuller and hammermill. One advantage of the lower-capacity dehuller and hammermill technology is that it allows small-scale entrepreneurs to expand gradually. Many operators started with only one dehuller and hammermill and expanded their operations as they gained experience, capital, and confidence in the market.

The commercial production and sale of sorghum mills (comprising dehuller and hammermill) was initiated by RIIC in 1977. This parastatal remains the main source of dehullers to the sorghum milling industry in Botswana. RIIC contracts out the manufacture of the dehuller to local industry. Manufacturers in Zimbabwe and South Africa are producing similarly designed dehullers.

## **Capital Investment Support**

The rapid growth of the sorghum milling industry can be attributed largely to financial support from the Government of Botswana. Virtually all sorghum mills received capital assistance to start or expand their operations. This came in the form of an enterprise development grant under the Financial Assistance Policy (FAP).

FAP was introduced in 1986 to generate employment and diversify the economy in sectors other than cattle production and mining (Govt of Botswana 1995). FAP funds are provided in the form of grants for up to 5 years (for industrial projects) to support new enterprises or expand existing ones. The grants are provided to citizens of Botswana, and cover up to 90% of the costs of small-scale projects. Priority is granted to projects in rural areas, projects owned by women, projects creating more jobs, and projects where the manager owns at least 35% of the enterprise. The owner must contribute at least 10% of the cost of the project. The maximum grant for small-scale enterprises is P 50,000 (approximately US\$ 10,500). A single enterprise may receive up to three grants totaling P 150,000; but the second and third grants are available only for the purchase of fixed assets.

Grants in rural areas are administered by local Production Development Committees and in urban areas by Administrative Committees. These are made up of both government officers and representatives of the private sector. The grants are administered through the National Development Bank.

Medium and large-scale FAP grants are available to anyone, though priority is given to citizens of Botswana and joint ventures between citizens and non-citizens. Capital grants are provided at P 1500 per job created for a citizen-owned project. An employment grant is provided as a reimbursement for wages of unskilled labor — 80% of the wage bill during the first two years, 60% in the third year, 40% in the fourth, and 20% in the fifth year. A business can also receive a grant for 50% of the costs of training provided during the first 5 years of the project.

In addition, new investments in the manufacturing sector are eligible for Automatic Financial Assistance (AFA). This entitles the recipient to a tax holiday on 100% of revenues during the initial year of investment, declining over the next 5 years, to 50% of revenues for rural projects and 25% for

urban projects. Grants are also awarded for 'sales augmentation,' where the enterprise receives a grant of 8% of sales revenue during the first 2 years of operation to encourage greater promotion of sales.

The maximum size of medium- and large-scale grants is 50% of the domestic value added (sales revenue minus tradeable inputs) over the 5-year grant period. Alternatively, a business can apply for a maximum of 80 to 130% of unskilled wage labor and training costs, depending on the location of the business. In general, medium-scale businesses receive grants between P 25,000 and P 900,000. Large-scale enterprises may receive grants over P 900,000 (US\$ 200,000).

The enterprise development subsidy particularly encouraged women to initiate milling businesses. Roughly 30% of the FAP grants for sorghum milling were provided to women. The majority of these were for the establishment of milling enterprises after 1995.

All the millers interviewed received FAP grants. The medium- and large-scale millers received finance for land, buildings, machinery, labor, and packaging. The smaller-scale millers tended to receive support for machinery, packaging, and labor. Some received financial assistance to purchase an initial allotment of grain. Information was not available on the size of grants provided to individual entrepreneurs.

Several millers received a second FAP grant to expand their businesses. These monies were used to purchase additional dehullers and hammermills, or expand land and buildings. At least one miller purchased a vehicle to facilitate the marketing of sorghum meal. None of the respondents received a third grant.

FAP grants were particularly helpful to entrepreneurs seeking to establish a milling business. In early 1999, a dehuller and hammermill with an electric motor cost approximately P 27,000, including the cost of installation and operator training. Thus, one grant of P 50,000 is enough to purchase a full set of milling equipment, a set of scales, a heat sealing machine, an initial allotment of sorghum, and pay for packaging and labor.

Approximately 75% of the sorghum mills in Botswana are owned by individual entrepreneurs. The majority of these installations consist of a single dehuller and hammermill. Most of these small-scale businesses were established during the 1990s. The remainder are owned by cooperatives and larger companies.

The FAP program appears to have substantially broadened participation in the milling industry. Almost all the mills benefiting from FAP grants are still in operation. Thus, the grants appear to have been successful in generating employment. However, the longer-term sustainability of many small-scale operations remains uncertain.

Several medium- and large-scale entrepreneurs expressed concern that the large subsidy implicit in the FAP grant has encouraged uncompetitive and unsustainable product pricing. Recipients of recent FAP assistance can afford to sell their sorghum meal at prices lower than the true production costs. This discourages investment by established millers who no longer qualify for FAP grants. At the extreme, such practices threaten the viability of established milling enterprises.

However, no direct evidence was found for this practice. Small-scale operators are more likely to suffer from cash flow and management constraints, than benefit from unsustainable pricing strategies. No evidence was found indicating that FAP grants were deliberately mishandled.

## **Sorghum Grain Supply**

The development of the sorghum milling industry has critically depended on the consistency of sorghum grain supply for commercial processing. This was a key constraint limiting the viability of the service milling industry. Sorghum might be widely available for a short period after harvest.

However, most farmers run out of grain well before the next harvest season. As a result, a service mill might run to capacity for a couple of months after harvest and then lie largely dormant for several months. Following drought, sorghum throughput might last only one to two months.

The milling industry initially relied on the Botswana Agricultural Marketing Board (BAMB) for most of its grain supply. Until 1992, BAMB had monopoly rights to import sorghum into the country. The government viewed restrictions on sorghum imports as a means to protect domestic producers and offer higher producer prices. Millers could purchase sorghum grain directly from farmers or from the Marketing Board. Since grain assembly costs were high, most simply used Marketing Board channels.

Yet these same assembly costs contributed to high margins between BAMB's grain buying and selling prices (Table 4). During the 1990/91 marketing season, for example, BAMB paid P 21.15 per 70-kg bag (P 302 per ton) of Grade A sorghum delivered to one of its depots in southern Botswana. The BAMB selling price for a similar bag was P 25.00 (P 357 per ton). Despite the 18% trading margin, BAMB lost money, because of the high costs of maintaining Botswana's Strategic Grain Reserve, and the need to manage a large number of depots country-wide. By 1995, in an effort to cover these costs, the margin between BAMB's domestic sorghum buying and selling prices had increased to P 155 per ton or 45% of the scheduled producer price.

Reliance on BAMB was further complicated by the inability of the parastatal to successfully manage the country's grain security stocks. BAMB was encouraged to maintain a stock of at least 80,000 t of grain. Yet the average annual off-take from the Marketing Board was less than half this level. Storage losses were reported to be high and millers complained about BAMB's failure to maintain clearly differentiated grain grades. In any given allotment, a miller could receive sorghum of highly variable quality. Sorghum derived from the domestic market was generally made up of a mixture of varieties with varying hardness, shape, and size. This inevitably reduced milling extraction rates.

Consequently, the few commercial millers operating during the late 1980s found it difficult to produce and price sorghum meal competitively with maize meal. Sorghum meal had to be priced 15-20% above maize meal on the retail market. These millers also complained about the limited viability of this market (Rohrbach 1988).

Botswana's sorghum trade was largely decontrolled in 1992. The purpose of import permits shifted from protection of domestic producers to tracking of import flows. Permits were now readily granted, allowing millers to purchase grain directly from neighboring countries. In consequence, the milling industry shifted to a reliance on direct imports of sorghum grain from South Africa.

The industry survey revealed that almost 90% of the grain used by the domestic sorghum milling industry in 1998 came from South Africa (Table 5). This includes approximately three-quarters of the

**Table 4. BAMB buying and selling prices for Grade A sorghum grain, 1990-99 (Pula per ton).**

	1990	1995	1999 (March)
Buying price	302.14	341.43	485.71
Selling price	357.14	496.43	628.57
Margin (% of buying price)	55.00 (18.2%)	155.00 (45.4%)	142.86 (29.4%)

Source: data obtained from K. Garebamono, Deputy General Manager, BAMB

**Table 5. Estimated quantities (t) of sorghum grain obtained from alternative sources by millers, 1998.**

Size of operation	South Africa	BAMB	Large-scale farmers in Botswana	Other
Large mills	34,702	1184	410	330
Medium mills	11,090	728	840	0
Small mills	7,704	2808	120	348
Total	53,496	4720	1370	678

Source: extrapolated from survey data

grain supplied to millers through BAMB. About 2% of the sorghum grain flowing through the domestic milling industry was grown by large-scale commercial farmers in Pandamatenga and the Barolong District. Zimbabwe was a small residual supplier.

Most of the millers sampled said they would like to increase their purchases from domestic producers, particularly from commercial farmers in Pandamatenga. However, in practice, most millers found it easier to maintain commercial links with South African traders.

Small-scale millers were more likely to obtain their sorghum grain from BAMB. Most of these millers do not have the capital for bulk purchases of imported grain. Nor do they have the throughput necessary to justify purchasing a full 37 t truckload. Some smaller millers band together to jointly purchase loads of grain originating from South Africa. However, most simply buy smaller lots of grain from BAMB when needed.

The total demand for sorghum grain by millers in 1998 is estimated to be approximately 60,000 t. Most of the millers interviewed during the survey were optimistic about the probability of expanding their throughput in 1999.

## **Non-Price Factors Influencing the Purchase of Sorghum Grain**

Competitiveness of prices is an important determinant of where grain is purchased, but it is not the sole factor guiding buying decisions. Millers in all three size classes indicated that the main factor was the consistency and timeliness of grain supply to the mill (Table 6). Commercial operations critically depend on a consistent level of throughput; and correspondingly, seek commercial links with only a few traders who can assure a steady supply of grain throughout the year. Most medium-scale operations rely on the delivery of a 37 t truckload of grain each week or two. Larger operations expect several truckloads a week.

One of the main problems restricting purchases from domestic farmers is the non-availability of grain throughout the year. Farmers with surplus production generally seek to sell immediately after the harvest. In consequence, this grain may be on the market for only two to three months a year. No miller has the capital to be able to purchase and hold large grain inventories. Rather, the industry has developed around a process of rapid rollover of inventory and capital. As the last part of one grain shipment is being milled into meal and shipped to the store, a new grain shipment is being received.

More often than not, the grain is purchased at the mill gate. The fact that the seller takes responsibility for transporting grain to the mill is particularly important for medium- and small-scale millers.

**Table 6. Main factors influencing sorghum grain purchase decisions, 1999.**

Size of operation	Factors most commonly cited
Large mills	<ul style="list-style-type: none"><li>• Consistency and timeliness of grain supply</li><li>• Cleanliness of grain</li><li>• Variety or grain quality</li></ul>
Medium mills	<ul style="list-style-type: none"><li>• Consistency and timeliness of grain supply</li><li>• Transport to the mill</li><li>• Availability of short-term credit</li><li>• Cleanliness of grain</li></ul>
Small mills	<ul style="list-style-type: none"><li>• Consistency and timeliness of grain supply</li><li>• Variety choice</li><li>• Cleanliness of grain</li><li>• Transport to the mill</li></ul>

The third major factor influencing the choice of grain sources is the cleanliness of the grain. None of the millers interviewed have grain cleaning equipment. This places a premium on quality, i.e. grain that has been mechanically threshed and is free of stones, sand, and dirt. Millers prefer grain that is free from chaff, but are willing to tolerate a low percentage of glumes and related plant matter which may be blown off during the process of dehulling. In contrast, sand and stones cause rapid wear of the dehulling equipment, and ultimately lead to grit in the meal. Retail demand for sorghum meal is quickly discouraged by sand in the product.

Sorghum purchased from Zimbabwe appears to have been particularly prone to sand and stones. This is because Zimbabwe's sorghum is generally threshed by hand on contaminated threshing floors. This problem has led to the rejection of several truckloads of sorghum imported from this country.

Millers are also concerned about grain hardness. Millers of all sizes generally seek grain of harder varieties, which offer higher extraction rates.

Most millers also express a preference for white-grained sorghum. In general, lighter color meal sells better than darker meal. Yet all imports from South Africa are of red sorghum, because most sorghum in South Africa is produced for their domestic brewing and malting industry. Also, red sorghums are less prone to grain mold than white sorghum (grain mold infestation generally occurs following rainfall during the harvest season). In contrast to South Africa, most of the sorghum grown in Botswana, as in neighboring Zimbabwe, is white in color.

Medium-scale millers expressed concerns about the availability of credit for grain purchases. Traders commonly offer credit terms requiring payment 14-30 days after the grain is delivered to the mill. This allows enough time for much of the grain to be milled and passed on to retail shops for sale.

The millers were asked directly why they did not purchase more grain from domestic producers. The main factors cited were inconsistency of grain supply and the limited quantities available (Table 7). Millers also complain about poor grain quality and dirty grain. Medium- and small-scale millers would be more likely to purchase from large-scale farmers if farmers undertook to transport grain to the mill gate.



## Sorghum Grain Prices

Due to the low levels of sorghum production in Botswana, the prevailing millgate prices roughly equal South African prices plus transport costs. Due to the convertibility of the Botswana pula, prices are just as commonly quoted in local currency as in South African rand.

The main source of differences in the grain prices paid by various millers is in the terms of payment. Millers can save money by purchasing grain in South Africa, and taking responsibility for transport costs. They are also more likely to be able to negotiate discounts on larger grain purchases. Discounts are also offered for cash payments or for payments within 14 days of receipt of grain, instead of 30 days.

In general, larger millers were better able to take advantage of the discounts associated with larger purchases and faster payments (Table 8). Millers purchasing smaller quantities of grain from BAMB generally paid 15-20% higher prices than those buying grain directly from South Africa. These millers also had to find their own transport to move the grain from a BAMB depot to their mill.

Prices of grain purchased from large-scale farmers in Botswana are roughly equivalent to the South African import price plus a small premium for the white grain color.

Consistent shortfalls in domestic grain production lead to higher sorghum grain prices on the rural market. Most small-scale farmers would prefer to keep their limited grain stocks rather than sell them to millers. Those few who have grain to sell generally have such small quantities that the assembly is unprofitable.

## Competitiveness of Domestic Sorghum Production

Smallholder production of sorghum for the commercial market in Botswana is essentially unprofitable at current yield levels, averaging less than 250 kg ha<sup>-1</sup> (Table 9). When ARAP was in place, until 1997, plowing services and seed were free of charge. Under these circumstances, the return to farm family labor was only P 4 per day, in comparison with P 8 per day for rural wage labor and P 25 per day for unskilled labor in the formal sector.

**Table 7. Factors limiting purchases from large- and small-scale farmers in Botswana, as cited by millers, 1999.**

From large-scale farmers	<ul style="list-style-type: none"><li>• Inconsistent supply or low output</li><li>• Lack of transport to the mill</li><li>• Poor quality grain</li></ul>
From small-scale farmers	<ul style="list-style-type: none"><li>• Little or no output</li><li>• High prices demanded</li><li>• Sorghum is not clean</li></ul>

**Table 8. Grain prices paid, cited by sorghum millers, Feb/March 1999.**

Size of operation	Price paid for grain imported from South Africa
Large mills	Pula 550-670 per ton
Medium mills	Pula 625-675 per ton
Small mills	Pula 620-690 per ton

Rand 1.3 = Pula 1.00

Now that these subsidies have been removed, the returns to sorghum production, at the prices offered by BAMB, are *negative*. Even if average sorghum yields double, the returns to family labor would still be too low to justify the investment in commercial production.

Several millers comment that farmers are asking too much for their sorghum grain. One cited a common request for the payment of P 70 per 70-kg bag, almost 50% higher than the prevailing grain price on the commercial market. And this is before the costs of grain assembly and transport to the millgate are taken into account. Yet the justification for this farmgate price is obvious. Sorghum productivity in the smallholder sector is simply too low for commercial production.

Sorghum production remains a subsistence activity in most of Botswana. Despite two decades of government subsidies for destumping costs, plowing services, seed, and some labor costs, the production system remains extensive in orientation. Farmers plow and plant a large area, but apply no manure or fertilizer. Weeding is common, but is generally done only once. And generally, less than two-thirds of the sorghum area planted is harvested. While this partly reflects the incidence of drought, the limited area harvested also reflects poor crop management.

Even in Pandamatenga, average sorghum yields remain too low to encourage substantial commercial investment in this crop. During the 1996/97 cropping season, yields ranged between 0.25 and 0.69 t ha<sup>-1</sup> among the eight farmers who were cited in the Pandamatenga Rehabilitation Study (Pandamatenga Commercial Farms Rehabilitation Task Force 1998). Each of these farmers reported a loss on their sorghum production. In consequence, most switched out of sorghum to cotton or sunflower the following season. This cropping pattern again prevailed during the 1998/99 season. Only three of the 20 commercial farmers at Pandamatenga still produced sorghum (C. Manthe, personal communication).

**Table 9. Returns per hectare from smallholder sorghum production, 1998/99.**

Input/Output	Mean yield scenario (250 kg ha <sup>-1</sup> )	High yield scenario (500 kg ha <sup>-1</sup> )
Plowing services	P 120	P 120
Seed (5 kg ha <sup>-1</sup> )	P 15.5	P 15.5
Gross return	P121	P 242
Gross margin	P 14.5 ha <sup>-1</sup>	P 106.5 ha <sup>-1</sup>
Returns per person-day of family labor (30 person-days of labor per ha)	P 0.48 per person-day	P 3.55 per person-day
Gross margin if plowing services and seed are free of charge (as under ARAP)	P 121 ha <sup>-1</sup>	P 242 ha <sup>-1</sup>
Returns per person-day of family labor if plowing services and seed are free of charge (30 person-days of labor per ha)	P 4.03 per person-day	P 8.07 per person-day

Overall, sorghum is a marginal source of income for most farm households. The returns to labor invested in crop production are simply too low and unstable to attract much investment in this enterprise. Instead, virtually every small-scale farmer aims to educate his or her children to qualify for employment off the farm. Such considerations underlie the rapid migration from rural to urban areas. Half the country's population now lives in urban areas or large rural business centers. While many urban-based households still maintain farms, these are not viewed as sources of investment income.

The impact of urbanization and the movement of labor off the farm has been mediated, since 1985, by government payments for the costs of destumping and plowing services. The destumping subsidy was removed in 1995, and the plowing subsidy was finally removed in 1997. This was also the first year, within the past decade, when farmers did not receive free sorghum seed. Due to the loss of production subsidies, as well as poor rainfall, Botswana's sorghum area declined from over 200,000 ha in 1988/89 to only 33,000 ha in 1997/98.

## Technical Efficiency

Given that most millers use the same source of grain, South Africa, and the same milling technology, RIIC-manufactured dehullers and hammermills, there are only limited differences in grain to meal extraction rates. Millers who carefully inspect the grain they purchase can obtain better extraction rates — around 80%. Yet some of the more commercialized millers also dehull their grain more thoroughly, thus obtaining a cleaner and marginally whiter sorghum meal. This drives down the extraction rate. Correspondingly, there was no clear difference in the extraction rates achieved by larger versus smaller millers (Table 10).

The larger difference in technical efficiency depends on the rate of grain throughput. This depends on the volume of grain milling, relative to capacity, and the existence of a consistent flow of grain through the dehuller and hammermill. Cleanliness of the grain can also affect the likelihood of breakdowns or equipment repairs.

In general, milling throughput is higher for large-scale commercial operations. RIIC reports that a dehuller has a capacity of 300 kg per hour. Assuming operation of at least 16 hours per day for 312 days a year, 1500 t of sorghum grain per year is needed for a single unit of equipment to run to capacity. In practice, most large commercial operations appear to be running at about half this capacity. Most small-scale operations are running at substantially less than half capacity.

The justification for under-utilization is not immediately apparent. Some operators complain about breakdowns of equipment. Efficiency is also lost as a result of the failure to replace grinding stones on a timely basis. When the grain contains stones and sand, the grinding stones wear down much faster than is the case with clean grain. However, the main source of inefficiency is likely to be limitations in the mill owner's financial and managerial capabilities. Strong financial management is necessary to ensure timely grain deliveries, and then rapid turnover of capital by moving the milled product to the retailer.

**Table 10. Grain to meal extraction rates cited by sorghum millers, 1999.**

Size of operation	Estimated extraction rate
Large mills	73-83% (one citing 50%)
Medium mills	60-83% (one citing 90%)
Small mills	70-86%

**Table 11. Wholesale price of sorghum meal cited by sorghum millers, Feb/March 1999.**

Size of operation	Price per 10 kg bag
Large mills	P 11.90-14.75
Medium mills	P 12.65-17.50
Small mills	P 12.70-18.95

## Product Pricing Strategies

The wholesale and retail prices of sorghum meal differ depending on scale of operation as well as the size and location of the market. Larger producers competing for consumers in urban and peri-urban markets tend to offer the lowest prices for sorghum meal (Table 11). This particularly relates to sales in and around Gaborone. Smaller millers located in outlying areas tend to charge marginally higher wholesale prices to local retail outlets. These are necessitated by smaller trading volumes and higher unit costs of distribution. Only one miller admitted offering additional discounts for purchases of larger volumes. Several millers noted that shopkeepers sometimes demand payments for shelf space. However, this could not be confirmed and does not appear to be a common practice.

A brief inventory was conducted of retail prices in several market centers. The results suggest strong price competition between a few large millers aiming to serve larger markets.

The response of consumers to differences in product pricing could not be clearly determined. Non-random discussions with shopkeepers and consumers indicated that consumers are influenced in their choice of alternative sorghum meal products by retail price, color of the meal, and quality of packaging. In general, consumers seem to prefer whiter meal. However, this was disputed by at least one miller who perceived a market niche for red sorghum meal. Evidence was found of consumers testing several products before settling on a preferred brand. Once this decision was made, consumers seem to stick with their decisions.

## Constraints to Growth

The prospects for further growth in the sorghum milling industry are uncertain. Based on their experience over the past 5 years, most respondents to the survey were optimistic about the likelihood that their milling throughput and sales could increase. This optimism is reinforced by fact that the industry has grown by 15% annually during the past 10 years (Table 12).

Substantial opportunity for expansion is also implicit in the fact that sorghum meal is a close substitute for maize meal. In early 1999, Botswana's annual consumption of maize meal was estimated at around 70,000 t. Per capita maize consumption appears to have been falling as sorghum consumption has increased.

Large-scale commercial operators were of a mixed view regarding the prospects for continuing industry growth (Table 13). Several voiced concerns about the growing competition from medium and small-scale commercial millers. As the scale of operations increases, finance is also an increasing worry. Medium-scale millers were generally optimistic about the prospects for industry growth. In contrast, small-scale operators commonly expressed uncertainty or skepticism about their growth prospects. Some expect to grow, but the majority simply regarded their prospects as uncertain.

Small-scale operators are relatively more dependent on FAP grants to support their operations. Correspondingly, the need for adequate finance was the most significant concern of smaller-scale operators — partly because sorghum grain is more expensive when purchased in smaller lots. In addition, these millers faced difficulty keeping their mills running on a consistent basis. As the FAP grants are used up, and wage and tax subsidies are lost, these firms are most vulnerable to collapse.

Medium and small-scale millers identified similar constraints limiting the prospects for their expansion (Table 14). These companies complained most about problems of obtaining consistent grain supplies and the pressures of competition.

Large-scale millers voiced particularly strong concerns about the difficulty of obtaining adequate supplies of high-quality grain at reasonable prices. This reflects greater worries about the technical efficiency of their operations.

Technical concerns also underlie complaints about the difficulties of maintaining a high-quality, motivated workforce. While several millers complained about the costs of rising wages, high rates of labor turnover appears a more pressing problem.

**Table 12. Estimated total quantity (t) of sorghum milled, 1990s.**

Size of operation	1990	1995	1998
Large mills	11,572	27,478	36,626
Medium mills	5500	8470	12,658
Small mills	0	840	10,980
Total	17,072	36,788	60,264

**Table 13. Prospects for growth in sorghum milling operation over the next 5 years, 1999.**

Size of operation	Summary of prospects cited
Large mills	Some expansion likely; limited by growing competition and finance
Medium mills	Generally expect to increase
Small mills	Most are uncertain of the market; some expect to increase and some not

**Table 14. Constraints cited by millers as limiting future expansion of the market over the next 5 years, 1999.**

Size of operation	Constraints cited
Large mills	<ul style="list-style-type: none"> <li>• Availability of high quality grain at acceptable price</li> <li>• Lack enough finance</li> <li>• Problems retaining good workers</li> </ul>
Medium mills	<ul style="list-style-type: none"> <li>• Lack enough grain</li> <li>• Too much competition</li> <li>• Lack enough finance</li> </ul>
Small mills	<ul style="list-style-type: none"> <li>• Lack enough finance</li> <li>• Too much competition</li> <li>• Lack enough grain</li> </ul>

The evidence obtained in these surveys suggests the commercial sorghum milling industry is due for a period of consolidation. Smaller firms with high input costs and lower managerial efficiency are likely to find it difficult to compete with medium-scale and large firms with stronger market links and a steadier grain throughput. Firms highly dependent on FAP subsidies are the most vulnerable. However, the likely structure of industry consolidation is not obvious. Smaller firms seeking to compete directly with medium and large firms, will be disadvantaged by higher grain costs, and higher operating costs per unit of output. Some of these firms are likely to go out of business - but some small firms may find a valuable market niche in outlying areas. Several may also compete on the basis of lower capital and managerial overheads.

The prospects for medium and large firms are likely to depend on their technical and allocative efficiency. Key variables include extraction rates, the level of throughput, and margins between grain buying and meal selling prices.

## **Issues for Industry Development**

Several issues arise which could dramatically influence the future development of the sorghum milling industry in Botswana.

### ***Future of sorghum production in Botswana***

Botswana does not appear to have a comparative advantage in crop production. While sorghum is relatively well suited to the semi-arid drought-prone agroecology characteristic of the country's arable lands, average grain yields remain extremely low relative to those of neighboring countries. Most starkly, sorghum yields in South Africa are almost 10 times the average yields obtained in Botswana. Average yields in Zimbabwe are at least twice as high. While yields alone are not an adequate measure of productivity, the magnitude of these differences offers a clue to the relative advantages of production in each country.

It is safe to assume that farmers obtaining yields of 250 kg ha<sup>-1</sup>, Botswana's average, are unlikely to produce for the commercial market. These farmers may obtain a surplus in the occasional year. However, this will not be enough to justify the investments in market infrastructure necessary to keep grain assembly costs at competitive levels. In effect, most of Botswana's farmers are likely to be net grain buyers, rather than net sellers.

The prospects for commercial sorghum production in places like Pandamatenga and the Barolong District remain uncertain. Farmers in both regions are shifting land out of sorghum. To shift back, commercial demand for sorghum, and indicative prices, will likely have to be declared at the beginning of the cropping season.

Two major benefits could result from the promotion of sorghum production for the domestic market. Domestic producers will reduce their grain transport costs to the millgate. And local farmers may be more willing to grow varieties suited to the needs of the milling industry, e.g. varieties with favorable extraction rates, color, and taste.

In order to encourage this production, millers need to work with a subset of farmers possessing stronger production skills and a commercial orientation, to encourage the production of specific varieties, perhaps by offering better prices for such varieties.

Millers could benefit by helping to ensure that seed of the right varieties is readily available to contracted farmers at planting time. This requires working with the Department of Research to encourage the multiplication and distribution of seed of these varieties.

The industry could also consider formal or informal contracting for the production of target volumes. This could include efforts to promote the marketing of grain through a limited number of assembly points. If farmers are assured of a ready market for their grain, greater investment may be justified in production inputs. Even limited improvements in the timeliness of planting, or weed control, may have significant impacts on grain yields.

### ***Role of the Botswana Agricultural Marketing Board***

Due to a number of inefficiencies, the parastatal Botswana Agricultural Marketing Board (BAMB) has largely lost the domestic sorghum market to South African traders. The inefficiencies include problems of grain grading, grain storage, inventory management, and — in common with some other parastatals — difficulties in keeping development costs (e.g. a large network of marketing depots, maintenance of national grain security stocks) distinct from its commercial operations. BAMB has declared its intention to more fully commercialize its operations, but whether it will be successful remains to be seen. Industry is skeptical.

BAMB is best positioned to serve small and medium-scale millers who have difficulties financing bulk purchases from South Africa. BAMB should be able to negotiate greater price discounts on large grain purchases in South Africa, or on the global market, than virtually any miller in the country. BAMB's capital costs ought to be lower than those of most major grain traders. However, this strategy must be complemented, by close attention to quality control. It is essential that grain be clean, and differences between grades be maintained. Storage losses must be minimized. BAMB will likely need to invest in better grain transport services.

BAMB can also play an essential role as a grain stockist on the domestic market. Smaller commercial farmers, in particular, aim to sell their grain within a month or two after harvest. Few companies or grain traders have the capital to purchase this crop and hold the inventory. Only one sorghum miller was identified who was willing to hold more than one month's stocks; all others seek to buy limited quantities on a weekly or bi-weekly basis. If BAMB can improve its efficiency, it may provide a competitive alternative to this marketing arrangement.

### ***Diversification of grain sources — sorghum imports from Zimbabwe***

In May 1999, sorghum prices in South Africa were approximately 50% higher than the prevailing price of white sorghum in Zimbabwe. However, substantial effort is required to develop sorghum trading links with Botswana's northern neighbor. Past efforts to source grain from Zimbabwe have been constrained by the contamination of grain with dirt, stones, and sand. This has led to the rejection of several truckloads of grain. Delays encountered in the export of grain from Zimbabwe, and controls on the size of grain trucks passing the border also limit the pursuit of these transactions.

The size of the current price differential between South African and Zimbabwean grain justifies a re-examination of these trading problems. The main constraint is grain cleaning, which can be quickly resolved by purchasing relatively simple equipment. This equipment is most logically purchased by grain traders aiming to sell sorghum on a consistent basis. However, smaller versions of grain cleaning equipment may also be purchased by Botswana's millers.

The main constraint to the purchase of larger volumes of Zimbabwean sorghum is the cost of grain assembly. White sorghum is not currently a commercial crop in the country, though several millers now produce sorghum meal on a small scale. The grain is widely dispersed in the country, particularly in drier regions with poor market infrastructure, low population densities, and considerable year to year variation in harvests. In consequence, grain assembly costs are high. Traders need to look for the grain and then encourage delivery to newly established buying points.

Yet the prospects for developing this trade are favorable. Zimbabwe is less drought-prone than Botswana and labor costs are lower. The Zimbabwe trade link also offers millers in Botswana the opportunity to obtain higher quality white sorghum varieties.

Recent devaluations of the Zimbabwe dollar have made domestic prices highly competitive. Correspondingly, initial investments in building trading links are likely to have a long-term payoff. If farmers start targeting production for the Botswana market, trade volumes could rapidly expand. At a minimum, Botswana would find an alternative supplier to the limited number of large-scale commercial farmers in South Africa.

### ***Sources of milling technology***

Botswana's milling industry is highly dependent on a single source of dehulling and milling technology — the government-supported Rural Industries Innovation Centre (RIIC). This technology has served the local milling industry well. However, continuing improvements in both the technology itself and its supply should be encouraged. Several medium and large-scale millers expressed an interest in the development of continuous-feed milling systems, partly because they offer substantially higher milling efficiency, and because of rising wage costs and difficulties in maintaining a high quality labor force. In this context, there may also be scope for considering a roller milling system as an alternative to the dehuller and hammermill.

RIIC's technical support, in the form of training in machine maintenance and the provision of spare parts, was also essential for the growth of the sorghum milling industry. However, as the industry expands, it is not clear that RIIC has a continuing comparative advantage in the provision of this support. There ought to be scope for privatizing and decentralizing the supply of spare parts.

### ***Marketing strategies for sorghum products***

Little evidence was encountered of investment in the advertising and promotion of alternative sorghum-based food products. Market intelligence appears to be based more on hearsay and sales trends than on surveys of consumer demand. Millers are therefore largely ignorant of the preferences of various groups of consumers, and unable to exploit market niches.

Questions about consumer preferences received contradictory responses. Some millers claim farmers like reddish meal. Most believe consumers prefer white meal. While most millers believe consumers like a meal that is coarser than maize meal, the consistency of this choice is unclear. Little is known about opportunities for targeting different products to the breakfast porridge market versus the stiff porridge market. Almost no work has been done on the development of alternative sorghum-based food products. Small quantities of sorghum are used in biscuit flour by at least one baker, but the size of this market is unknown.

If sorghum meal is to compete successfully with maize meal, larger investments will probably be required in both product promotion and market evaluation. The initial impetus to such market development may come from rising competition between the suppliers of a relatively undifferentiated sorghum meal product. Further development of the industry will likely require greater product differentiation as well as exploitation of market niches.



## Lessons

Four major factors underlie the growth of the sorghum milling industry in Botswana. First, domestic consumers widely prefer sorghum meal. The rapid growth of Botswana's population relative to its sorghum production led to an increasing reliance on maize imports. By the early to mid-1980s Botswana was consuming twice as much maize as sorghum grain. Rising incomes during the last two decades similarly encouraged rapid growth in the consumption of wheat products and rice. Yet sorghum remains a preferred staple in many households.

The recent growth of the sorghum milling industry has allowed sorghum to compete with maize meal as a commercial food product. The easy availability of sorghum meal on the retail market, at a price little different from maize meal, has led to a decline in the growth rate of maize consumption.

Second, grain dehulling and milling technology was readily available, and strong efforts were made by a local parastatal to encourage the use of this technology. The technology provided a good quality meal product despite variability in the quality of sorghum grain. The parastatal facilitated access to the technology as well as the training to use it efficiently. Spare parts and repair services were readily available. Importantly, this technology also allowed millers to gradually expand processing capacities as the market developed. An entrepreneur could start with a small-scale operation and then expand as resources and demand permitted.

Third, the Government of Botswana provided the industry with financial support, encouraging investment in new technology and plant. The grants provided under the FAP sharply limited the risks that new entrepreneurs faced. The grants allowed millers to learn their craft and encouraged spillover gains on the manufacture of dehulling and milling equipment.

Finally, the growth of the industry depended on the consistent availability of acceptable quality grain necessary to operate throughout the year. While the government would have preferred that this grain come from farmers in Botswana, barriers to grain imports were ultimately eliminated. This encouraged individual millers to develop links with grain traders in South Africa, and explore links with traders in Zimbabwe and Zambia.

The replicability of these conditions in other parts of the African continent remains uncertain. Sorghum is a staple food in pockets of southern and eastern Africa, though maize has historically (over the past 50 years) dominated these food systems.

Efforts have been made to promote the distribution of the dehulling and hammermilling technology in a number of other African countries, with limited success. In Zimbabwe, more than 40 dehullers were distributed in rural areas and remain largely used for service milling of maize. Related projects in Zambia, Tanzania, and Swaziland have been less successful.

The financial support package offered by the Government of Botswana is unique. The package sharply reduced the risks of business development and encouraged millers to commercialize their operations. The success of the small-scale milling industry in Botswana suggests that scope exists to target small-enterprise grants (or loans) toward the development of such food processing sectors. Concessional interest rates, and targeted lending, may be more important than the amount of the grant per se.

Finally, as the millers commonly reminded us, access to good quality grain throughout the year is essential. This requires that some group other than the millers hold the inventory. In the case of Botswana, the reduction of sorghum import barriers allowed a steady stream of grain to flow from farmers, grain cooperatives, and individual traders based in South Africa. Millers had the opportunity to negotiate directly with these traders and to individually import grain. The ready availability of sorghum grain from South Africa eliminated the need to invest in the development of domestic grain assembly. The risks of unreliable grain supply were sharply reduced and the level of investment required to source grain was limited. Millers in other African countries may need to invest more in developing grain supply links or contracts with groups of farmers.

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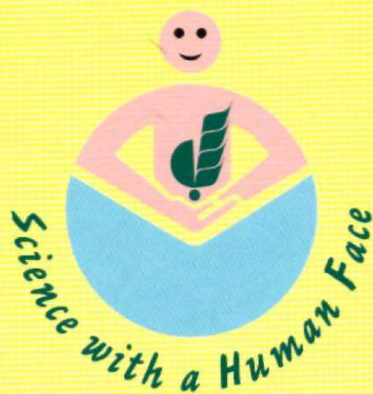
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## **About ICRISAT**

The semi-arid tropics (SAT) encompass parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the semi-arid tropics. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 16 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank.



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